for many patients have not hitherto been met."

The last section of the volume is an admirable summary of the subject. We hope it will be read by, and give fresh heart to, all engaged in national tuberculosis work. We wish it could be brought home also to the hearts and minds of central and local governing bodies, who, unfortunately, at the present time, are engaged in whittling down essential public health activities, which is anything but economy of the welfare of the Commonwealth, on which efficiency depends.

Physics and Chemistry of Bioluminescence.

The Nature of Animal Light. By Prof. E. N. Harvey. (Monographs on Experimental Biology.) Pp. x + 182. (Philadelphia and London: J. B. Lippincott Co., 1920.) 10*s.* 6*d.* net.

BIOLUMINESCENCE—that is, the production of light by animals and plants—is a phenomenon which has excited wonder in the layman and given rise to many investigations on the part of the man of science. Since the results of these investigations, many of them of a purely qualitative nature, are widely scattered in the literature of various countries and not always readily accessible, the author has rendered a distinct service in collating the various facts and presenting them to the scientific public as a connected whole. The biological aspect is referred to but briefly, in a chapter on the structure of the luminous organs, the main portion of the book dealing with the physical characteristics of animal light and the chemical processes underlying its production. The study of bioluminescence is another instance of the application of physics and chemistry to biological and physiological problems; the author's treatment is clear and, so far as the present state of our knowledge is concerned, convincing; it shows, moreover, that he has full command of the cognate sciences.

After providing, in the first two chapters, an account of the physical phenomena of luminescence and incandescence, in which, especially, the various kinds of luminescence are adequately discussed, a detailed description is given of the results obtained in the physical investigations of the nature of animal light. It is in such physical investigations that most progress of a definite nature seems to have been made. Exact quantitative measurements have established that the light emitted is in no way different from ordinary light, except in intensity and spectral extent; it is all visible light, containing no infra-red or ultra-violet radiations or rays which are capable of penetrating opaque objects. Like ordinary light, it will cause fluorescence and phosphorescence of substances, affect a photographic plate, cause marked heliotropism of seedlings, and stimulate the formation of chlorophyll.

The efficiency (= visible radiation × visual sensibility ÷ total radiation) of the firefly as an illuminant seems to be of the order of 96 per cent.—that is, immeasurably superior to any artificial source of light. The light, however, supposing it could be put to use, would not be suitable for artificial illumination, since all objects would appear a nearly uniform green hue. Although the light of the firefly is the most efficient known, so far as amount of light for expenditure of energy is concerned, it has been produced at the inevitable expense of range of colour.

The last three chapters deal with the chemistry of light production and the dynamics of luminescence. As is only to be expected from the nature of the case, the chemistry of bioluminescence has not yet been placed on a basis as satisfactory as the physics thereof; the evidence, as yet, is mainly of a qualitative nature. It seems to be established that, in at least three groups of animals, luminescence is due to the interaction of two substances, luciferin and luciferase, in the presence of water and oxygen. Luciferase is a protein, all its properties agreeing with those of the albumins, and may be regarded as an enzyme; luciferin has many properties in common with the proteoses and peptones, but its chemical nature still remains to be decided. The stage to which our knowledge of the dynamics of animal luminescence has advanced may be indicated by the fact that the author only commits himself to the statement that "perhaps the reaction takes place in two stages," a compound luciferin–luciferase being first formed and then undergoing oxidation.

A valuable bibliography is given at the end of the book, which is printed in clear type and well supplied with illustrations and diagrams.

T. S. P.

Our Bookshelf.

The Arithmetic of the Decimal System. By Dr. J. Cusack. Pp. xvi + 492. (With answers.) (London: Macmillan and Co., Ltd., 1920.) 6*s.*

DR. CUSACK is a firm believer in the decimal system, and there can be no doubt that he speaks with some authority, in view of the great experience he has enjoyed of teaching arithmetic and other branches of a business training to all classes of pupils. Many have argued theoretically about the educational and commercial advantages of a

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decimal system, as against the complicated notations now in use in this country, and some have worked out decimal systems which they considered suitable for introduction by Act of Parliament. Dr. Cusack has gone a step further by producing a text-book of arithmetic in which the calculations are all in terms of the decimal notation, and the various quantities dealt with, like length, area, volume, weight, and money, are all decimalised.

The author does not desire to introduce the *metric* system. This is merely one form of decimal system, and Dr. Cusack considers that we in this country are so much accustomed to the use of the yard, the hundredweight, the gallon, the pound sterling, etc., that it is necessary to retain these units in any decimal system we employ. The effect of the acceptance of this idea would therefore be merely the abolition of the vulgar fraction in business and other calculations; the difference between the English and the Continental units would still remain. This is not the place for a discussion of the problem, but it must be pointed out that a considerable fraction of the advantages derivable from such a radical change of our English system of units would be lost if we refused to fall in with the Continental metre, gramme, and litre. As regards money units, the matter is entirely different—international exchanges have such huge relative time-gradients that it is idle to attempt any international equalisation of the currency.

Dr. Cusack's book is excellently written and produced. It is really a piece of propaganda literature, and as such it should have more effect than any number of Parliamentary speeches and Chamber of Commerce resolutions in educating public opinion in the direction of accepting a long-overdue reform of our system of units.

S. BRODETSKY.

Annales de l'Observatoire astronomique de Tokyo. Tome 5, 4e fascicule. Studies on Astronomical Time-Keepers and Time-Preserving Systems. By Kiyofusa Sôtome. Pp. ii + 59. (Tokyo: Imperial University, 1921.)

THE problem of the determination and distribution of accurate time has been advanced considerably in recent years by the use of the moving wire in observing transits, and the introduction of wireless time-signals. Hence the analysis of the behaviour of high-class time-keepers under various conditions, which is dealt with in this memoir, is likely to be of general utility. Mr. Sôtome notes that chronometers are essential in Japanese observatories as a supplement to pendulum clocks, on account of the prevalence of earthquake shocks, which produce abrupt changes on the error and rate of a clock, but have no sensible effect on a chronometer. It is shown that the chronometer rates are sensitive to changes of atmospheric pressure and humidity, so that an air-tight case should be used. Most of the chronometers showed perceptible change of rate according to the interval that had elapsed since winding; this change was diminished by using a falling weight instead of a spring as motive power, a method that is practicable in an observatory, but not at sea.

The section on pendulum clocks deals not only with those at Tokyo, but also with the records of the standard clocks of several European observatories. There is a curious general tendency to acceleration of rate, which may be due to accumulation of dust, rust, etc., on the rod and bob. An examination is made of the properties of different metals that are used as pendulum rods; it is found that invar is subject to gradual elongation and irreversible thermal expansion; quartz or tungsten are suggested as suitable. The importance of an air-tight chamber, with constant pressure and temperature, is emphasised.

Finally, the memoir deals with the determination of true time, which involves the distribution of error between the transit observation and the timepiece. It is suggested that abnormalities in the former may sometimes be due to lateral refraction, arising from unsymmetrical temperature distribution. The ratio of probable errors of the observed transit and the assumed clock rate having been found by experience at each observatory, formulæ are given for obtaining a weighted mean clock error.

A. C. D. CROMMELIN.

String Figures. By W. W. Rouse Ball. Second edition. Pp. 69. (Cambridge: W. Heffer and Sons, Ltd., 1921.) 2*s.* 6*d.* net.

THIS book is a second and enlarged edition, of which we have already noticed the first issue (NATURE, vol. 106, p. 640). The subject is comparatively new, though one variety, the cat's cradle, has a literary pedigree from the eighteenth century, and the boys at Christ's Hospital used to play it in the time of Charles Lamb, as related by that charming writer in his essay on the famous foundation; but the discovery of the more interesting forms dates from the Cambridge expedition to Torres Straits in 1898 under the leadership of Drs. Haddon and Rivers. Since then many interesting figures have been recorded, notably in America, by Mrs. Jayne.

The invention is certainly due to the lower culture, and the distribution of the figures is very interesting. That known as "Lightning" comes from the Navaho Indians of Arizona; the now almost extinct Apaches passed on the "Tent Flap" to the Mexican Indians; "Man Climbing a Tree" comes from the Queensland blacks; the "Batoka Gorge" was accidentally discovered by someone who showed some other figures to the native police escort at the Victoria Falls. In fact, as Mr. Ball tells us, no self-respecting anthropologist ought to go about without a piece of string in his pocket. As anyone can now learn a fascinating game under his careful guidance, it may be hoped that field anthropologists will soon tell us more about its various methods and its origin.

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